

1 CLAIMS:

2 / 1. A method of forming a line of FLASH memory cells  
3 comprising:

4 forming a line of floating gates over a semiconductor substrate;  
5 providing a series of spaced trenches at least 2000 Angstroms  
6 deep within the semiconductor substrate in a line adjacent and along  
7 at least a portion of the line of floating gates; and

8 implanting conductivity enhancing impurity into the semiconductor  
9 substrate beneath the trenches, along sidewalls of the trenches and  
10 between the trenches and forming therefrom a continuous line of source  
11 active area within the semiconductor substrate along at least a portion  
12 of the line of floating gates.

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14 2. The method of claim 1 wherein the spaced trenches are  
15 provided by etching trenches into the semiconductor substrate and  
16 subsequently filling the trenches by depositing insulating material, and  
17 thereafter removing a majority of said insulating material from the  
18 trenches immediately adjacent the line of floating gates along said  
19 continuous line of source active area being formed.

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21 3. The method of claim 1 comprising providing the series of  
22 spaced trenches before forming the line of floating gates.  
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1           4.     The method of claim 1 wherein the implanting comprises at  
2     least one implant conducted at an angle from normal to a general  
3     orientation of the semiconductor substrate.

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5           5.     The method of claim 1 wherein the spaced trenches have  
6     sidewalls, the sidewalls extending along a line from an outer surface of  
7     the semiconductor substrate to a floor of the respective trenches, the  
8     line being straight along a majority of its length.

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10          6.     The method of claim 1 wherein the spaced trenches are  
11     provided by LOCOS and removal of oxide produced by said LOCOS.

1           7.    A method of forming a line of FLASH memory cells  
2 comprising:

3           forming a line of floating gates over a semiconductor substrate;  
4           providing an alternating series of trench isolation regions and  
5 active area regions in the semiconductor substrate in a line adjacent  
6 and along at least a portion of the line of floating gates;

7           removing isolation material from trenches of the trench isolation  
8 regions;

9           after the removing, implanting conductivity enhancing impurity into  
10 the semiconductor substrate within the active area regions and beneath  
11 the trenches and forming therefrom a continuous line of source active  
12 area within the semiconductor substrate along at least a portion of the  
13 line of floating gates.

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15           8.    The method of claim 7 wherein the trench isolation regions  
16 are provided by etching trenches into the semiconductor substrate and  
17 subsequently filling the trenches by depositing insulating material.

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19           9.    The method of claim 7 comprising providing the series of  
20 spaced trenches before forming the line of floating gates.

1           10. The method of claim 7 wherein the implanting comprises at  
2           least one implant conducted at an angle from normal to a general  
3           orientation of the semiconductor substrate.

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5           11. A method of forming a line of FLASH memory cells  
6           comprising:

7           forming a line of floating gates over a semiconductor substrate;  
8           etching into the semiconductor substrate to form a series of  
9           spaced trenches within the semiconductor substrate in a line adjacent  
10          and along at least a portion of the line of floating gates; and

11          conducting at least one conductivity enhancing impurity implant  
12          into the semiconductor substrate at an angle away from normal to a  
13          general orientation of the semiconductor substrate to implant at least  
14          along sidewalls of the trenches and between the trenches, and forming  
15          a continuous line of source active area within the semiconductor  
16          substrate along at least a portion of the line of floating gates.

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18          12. The method of claim 11 comprising conducting at least one  
19          conductivity enhancing impurity implant into the semiconductor substrate  
20          at an angle normal to the general orientation of the semiconductor  
21          substrate.

1 13. The method of claim 11 wherein the trenches are effectively  
2 deep to preclude forming a continuous implant region at bases of the  
3 trenches from said at least one angled implant, and further comprising  
4 conducting at least one conductivity enhancing impurity implant into the  
5 semiconductor substrate at an angle normal to the general orientation  
6 of the semiconductor substrate to implant into the trench bases.

7  
8 14. The method of claim 11 comprising forming trenches to be  
9 at least 3000 Angstroms deep, and conducting at least one conductivity  
10 enhancing impurity implant into the semiconductor substrate at an angle  
11 normal to the general orientation of the semiconductor substrate.

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13 15. The method of claim 11 wherein the conducting occurs after  
14 filling the spaced trenches by depositing insulating material and removing  
15 a majority of said insulating material from the trenches immediately  
16 adjacent the line of floating gates along said continuous line of source  
17 active area being formed.

1 16. A method of forming a line of FLASH memory cells  
2 comprising:

3 forming a line of floating gates over a semiconductor substrate;  
4 etching into the semiconductor substrate to form a series of  
5 spaced trenches within the semiconductor substrate in a line adjacent  
6 and along at least a portion of the line of floating gates, the spaced  
7 trenches comprising sidewall portions angled at least 15° from normal  
8 to a general orientation of the semiconductor substrate;

9 depositing insulating material to within the trenches and thereafter  
10 removing a majority of said insulating material from the trenches  
11 immediately adjacent the line of floating gates along a continuous line  
12 of source active area being formed along at least a portion of the line  
13 of floating gates; and

14 implanting conductivity enhancing impurity into the semiconductor  
15 substrate beneath the trenches, along the trench sidewalls and between  
16 the trenches and forming therefrom said continuous line of source active  
17 area within the semiconductor substrate along at least a portion of the  
18 line of floating gates.

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20 17. The method of claim 16 wherein the trench sidewall portions  
21 are angled at least 20° from normal to the general orientation of the  
22 semiconductor substrate.  
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1           18. The method of claim 16 wherein the trench sidewall portions  
2 are angled at least 30° from normal to the general orientation of the  
3 semiconductor substrate.

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5           19. The method of claim 16 wherein the trench sidewall portions  
6 are angled at least 40° from normal to the general orientation of the  
7 semiconductor substrate.

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9           20. The method of claim 16 wherein the implanting comprises  
10 at least one implant conducted at an angle away from normal to the  
11 general orientation of the semiconductor substrate.

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13           21. The method of claim 16 wherein the implanting comprises  
14 at least one implant conducted at an angle normal to the general  
15 orientation of the semiconductor substrate.

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17           22. The method of claim 16 wherein the implanting comprises  
18 at least one implant conducted at an angle normal to the general  
19 orientation of the semiconductor substrate, and at least one implant  
20 conducted at an angle away from normal to the general orientation of  
21 the semiconductor substrate.

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23. The method of claim 16 comprising etching the series of spaced trenches before forming the line of floating gates.

24. A method of forming a line of FLASH memory cells comprising:

forming a line of floating gates over a semiconductor substrate;  
providing an alternating series of trench isolation regions and active area regions in the semiconductor substrate in a line adjacent and along at least a portion of the line of floating gates, the series of active areas defining discrete transistor source areas separated by trench isolation regions;

forming a conductive line over the discrete transistor source areas and trench isolation regions separating same adjacent and along at least a portion of the line of floating gates, the conductive line electrically interconnecting said discrete transistor source areas; and

providing source forming conductivity enhancing impurity into the discrete transistor source areas.

25. The method of claim 24 wherein a majority of the source forming impurity is provided before forming the conductive line.





1           29. A method of forming a line of FLASH memory cells  
2 comprising:

3           forming a line of floating gates over a semiconductor substrate;  
4           providing an alternating series of trench isolation regions and  
5 active area regions in the semiconductor substrate in a line adjacent  
6 and along at least a portion of the line of floating gates, the series of  
7 active areas defining discrete transistor source areas separated by trench  
8 isolation regions;

9           forming conductively doped semiconductor material over the  
10 discrete transistor source areas and trench isolation regions separating  
11 same adjacent and along at least a portion of the line of floating gates  
12 which electrically interconnects said discrete transistor source areas;

13           out diffusing source forming conductivity enhancing impurity into  
14 the discrete transistor source areas from the conductively doped  
15 semiconductor material; and

16           patterning the conductively doped semiconductor material into a  
17 conductive line.

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19           30. The method of claim 29 wherein the conductively doped  
20 semiconductor material is capped with a conductive silicide layer.

1           31. The method of claim 29 wherein the conductively doped  
2 semiconductor material is capped with a conductive silicide layer prior  
3 to the patterning.

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5           32. A method of forming a line of FLASH memory cells  
6 comprising:

7           forming a line of floating gates over a semiconductor substrate,  
8 the line of floating gates having a source side and a drain side;

9           depositing an insulative sidewall forming layer over the line of  
10 floating gates; and

11           forming an insulative sidewall spacer on one of the source side  
12 and the drain side before the other by anisotropically etching the  
13 insulative sidewall forming layer.

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15           33. The method of claim 32 wherein the source side insulative  
16 spacer is formed before the drain side insulative spacer.

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18           34. The method of claim 32 wherein the drain side insulative  
19 spacer is formed before the source side insulative spacer.

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21           35. The method of claim 32 wherein the other side is masked  
22 with photoresist while the insulative sidewall spacer on the one side is  
23 being formed.

1           36. A method of forming a line of FLASH memory cells  
2 comprising:

3           forming a line of floating gates over a semiconductor substrate,  
4 the line of floating gates having a source side and a drain side;

5           depositing an insulative sidewall forming layer over the line of  
6 floating gates; and

7           in one anisotropic etching step of the insulative sidewall forming  
8 layer, forming an insulative sidewall spacer on only one of the source  
9 side and the drain side and not the other.

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11           37. The method of claim 36 further comprising in another  
12 anisotropic etching step, forming an insulative sidewall spacer on the  
13 other side.

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15           38. The method of claim 36 wherein the other side is masked  
16 with photoresist while the insulative sidewall spacer on the one side is  
17 being formed.

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19           39. The method of claim 36 wherein no insulative sidewall  
20 spacer is ever formed on the other side.

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22           40. The method of claim 36 wherein the one side is the source  
23 side.

1 41. The method of claim 36 wherein the one side is the drain  
2 side.

3  
4 42. A line of FLASH memory cells comprising:  
5 a line of floating gates received over a semiconductor substrate;  
6 an alternating series of trench isolation regions and active area  
7 source regions in the semiconductor substrate formed in a line along at  
8 least a portion of the line of floating gates, the source regions being  
9 conductively doped with a conductivity enhancing impurity and separated  
10 by the trench isolation regions; and

11 a conductive line formed over the source regions and trench  
12 isolation regions along at least a portion of the line of floating gates,  
13 the conductive line electrically interconnecting said source regions.

14  
15 43. The line of claim 42 wherein the trenches are formed at  
16 least 2000 Angstroms deep into the semiconductor substrate.

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18 44. The line of claim 42 wherein the conductive line comprises  
19 conductively doped polysilicon capped with a conductive silicide.  
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